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(54) Underwater device with a sacrificial latch mechanism

Unterwasservorrichtung mit einem Verriegelungsmechanismus mit Sollbruchstelle

Dispositif sous-marin avec dispositif de verrouillage sacrificiel

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(73) Proprietor: **Input/Output, Inc.**
Stafford, TX 77477 (US)

(72) Inventor: **Rau, Brien G.**
Jefferson, Louisiana 70121 (US)

(74) Representative: **Harrison, David Christopher et al**
MEWBURN ELLIS
York House
23 Kingsway
London WC2B 6HP (GB)

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Description

[0001] The invention relates to marine seismic prospecting and, more particularly, to a device attached to an underwater cable by a sacrificial latch mechanism.

[0002] In marine seismic exploration, a streamer cable is towed underwater behind a survey vessel. An array of hydrophones is mounted in the cable, and a seismic source, or gun, is fired to generate seismic energy that radiates through the water and into the earth. Reflections of the seismic energy off geologic structures are sensed by the hydrophones. Data representing the detected energy are transmitted to the vessel for later processing to produce maps showing subsea formations likely to contain oil and gas.

[0003] To create accurate maps, it is necessary to know the shape of the streamer cable during the seismic data-gathering process. For this purpose, depth control devices, commonly referred to as cable-leveling "birds," are attached to the cable at intervals along its length. The depth control devices are equipped with adjustable diving planes, or wings, whose angles of attack can be varied by motor to maintain a preselected depth. The depth control devices frequently include highly accurate heading sensors, or digital compasses, whose heading outputs are transmitted to the vessel. From the compass heading data, the shape of the cable can be accurately determined.

[0004] Typically, each depth control device is detachably connected to the cable by one or more collars, which are attached to the cable. Each collar comprises cylindrical inner and outer races surrounding the streamer. The inner race is affixed to the streamer. The outer race, to which the depth control device is semi-permanently attached, can freely rotate about the inner race and, hence, the streamer. The outer race, which may be hinged for easy removal from and attachment to the inner race, has a slot for engagement by a locking bolt extending out of the depth control device to retain the device to the outer race. An exemplary collar mechanism is described in US Patent No. 5,507,243, "CONNECTOR FOR UNDERWATER CABLES," April 16, 1996. The locking bolt is adjustable between locked and unlocked positions as part of a latch mechanism. The locking bolt and other parts of the latch mechanism reside wholly or partly in cavities in the housing of the depth control device. Internal surfaces of the housing serve as bearing surfaces for the various elements of the latch mechanism. A typical latch mechanism is described in US Patent No. 5,214,612, "SWING PLATE LATCH MECHANISM," May 24, 1993.

[0005] As the streamer is towed through the water, it often happens that jetsam and other debris collide with the devices attached to the cable. Depending on the size of the debris and the tow speed of the vessel, the impact on the devices can be severe. Strong impacts can also result during payout and retrieval of the streamer from collisions with structures on the vessel. These impacts can exert strong forces on the devices that can deform or even fracture the housings. Damaged housings can result in seawater intrusion into the electronics in the devices, binding of the wings, or broken latch mechanisms. In these instances, the housing must clearly be replaced. Even if the force of impact causes only a slight deformation of the housing, the accuracy of the heading sensor contained within can be compromised if the deformation changes the relative alignment of the housing to the cable. A deformation causing even a 1° or smaller change in alignment may be unacceptable in certain seismic applications. Typically, the solution is to replace the deformed device with an undeformed device. Damaged or deformed housings typically cannot be repaired and must be discarded. Even though the internal electronic components can be salvaged, they must typically be removed, reinstalled, and calibrated at the factory. Thus, it is clear that damaged or deformed housings can add significantly to the cost of outfitting and maintaining a streamer cable.

[0006] Clearly there is a need for avoiding permanent damage to expensive parts and for making field repairs possible in the inevitable event of collisions between cable-attached underwater devices and shipborne structures or underwater debris.

[0007] This need and others are satisfied by an underwater-cable-connected device having features of the invention as defined in claim 1, which includes a housing, a retainer, and a latch mechanism with a latch body attached to the housing by the retainer in normal operation. A locking member extends between the latch body and a mounting element to hold them together securely in a locked position connecting the device to the cable. When forces, such as those resulting from collisions with underwater debris, act on the latch body, a sacrificial element gives way to release the attachment of the latch body to the housing by the retainer before the forces reach a level sufficient to damage the housing.

[0008] In a preferred version of the invention, the latch body resides in a cavity in the housing. The locking member is retained in a chamber in the latch body and is movable between locked and unlocked positions engaging and disengaging with the mounting element, typically a receptacle in an outer collar race. The sacrificial element may be realized in various ways. In one version, the latch body forms a bore through which the retainer extends into the housing to retain the latch body to the housing. The housing may be made of a stronger material than the latch body. A portion of the latch body around the bore, for example, the portion between the bottom side of the latch body and the bore, is relatively thin and gives way under forces tending to separate the device from the cable before the main housing is deformed or otherwise damaged. In this way, only the relatively inexpensive sacrificial latch body need be replaced, rather than the entire underwater device. The replacement of the latch body is simple enough that it

can be done on the back deck of the vessel or even in the water from a small support boat when the cable is surfaced.

[0009] In other versions, the sacrificial element can be a portion of the retainer that breaks when the force reaches too great a level. In yet another version, the housing has an access hole that extends into the latch cavity. An access aperture extending into the chamber of the latch body is aligned with the access hole in the housing to admit an insertable tool that can be used to lower and raise the locking member or pin into and out of locking engagement with the mounting element. One version of the tool has an eccentric camming surface on which the locking pin rides up and down between locked and unlocked positions as the tool is rotated. External tool access to the locking member eliminates the need for permanently installing a relatively costly camming element in each latch mechanism.

[0010] These and other features, aspects, and advantages of the invention are better understood by referring to the following description, appended claims, and accompanying drawings, in which:

FIG. 1 is a perspective view of an underwater device embodying features of the invention attached to a section of streamer cable;

FIG. 2 is a perspective view showing a typical arrangement for connecting the underwater device of FIG. 1 to the outer race of a mounting collar;

FIG. 3 is a cross-sectional side elevation view of a portion of the housing of the underwater device of FIG. 1 showing a latch mechanism embodying features of the invention;

FIG. 4 is an exploded perspective view of the latch mechanism of the underwater device of FIG. 1, showing a latch body and a latching/unlatching tool;

FIG. 5 is a perspective view of the latch body of FIG. 4 after undergoing a force sufficient to break it before the housing is damaged; and

FIGS. 6A and 6B are perspective views of another version of the invention showing a sacrificial retainer before and after fracture.

[0011] An exemplary version of the underwater device 20 embodying features of the invention is shown in FIGS. 1-5. The device depicted in FIG. 1 is a cable-leveling bird attached to a streamer cable 21. The bird housing 22 includes a tubular main body section 24 and a front pylon 26 and a rear pylon 28. Two motor-driven fins 30, or wings, extend from the main body section to control the depth of the cable. A pressure sensor in the front pylon is used to determine the depth of the bird so that the wings can be appropriately adjusted to maintain a desired depth. The housing 22 also contains the motor and other electronic components used to control the wings, read the pressure sensor, and communicate with a towing vessel over wires in the cable 21. The bird may also house a heading sensor 30, or digital compass, to provide a highly accurate indication of the orientation of the cable. The heading information relayed to the vessel is used to determine the shape of the cable during a seismic prospect. The calibrated heading sensor is accurately aligned in the housing 22 along a heading axis 32 aligned with the axis of the tubular main body section, which serves as the bird's heading reference axis.

[0012] Collar rings 34 are firmly clamped around the cable 21 at front and rear mounting positions. The rings form an inner race to accommodate a connector assembly 36, which can freely rotate about the ring and, hence, the cable. Although it does not have to be, the connector could be a hinged assembly with removable hinge pins 38, such as the Quick Latch™ collar assembly manufactured by DigiCOURSE, Inc. of Harahan, LA, or could be an unhinged, or other, assembly providing a means of attachment to the cable. As shown in FIG. 2, the connector 36 includes a receptacle 40, in the shape of, for example, a keyhole with a large opening 41 at one end and a slot 42 at the other end. A typical connector has a second similar receptacle 180° around its circumference to similarly accommodate another device, such as a flotation tube. The connector 36 is attached to the bird by a locking member 44, preferably a dovetail pin, extending from the pylons 26, 28 of the housing 22. To avoid redundancy, subsequent descriptions focus on the attachment to a mounting element at the front pylon 26, but apply also to the attachment at the rear pylon 28. The preferred locking pin 44 has a pair of opposite horizontal grooves 46 just below its top 48. The circumference of the top is just less than the circumference of the large opening 41 in the receptacle 40. The opposing grooves are dimensioned to allow the locking pin 44 to slide along the slot 42 in the receptacle to its end opposite the large opening. In this way the locking member engages the receptacle of the connector securely in a locked position. A lock screw 50 tightened into a threaded hole 51 in the pylon or other similar fastener offset along the slot 42 from the locking pin can be used to provide a more stable two-point retention of the pylon 26 to the connector 36.

[0013] Further details of a preferred version of a latch mechanism 52 are shown in FIGS. 3-4. The housing pylon 26 includes a latch cavity 54 sized to receive a latch insert body 56. The latch body has a top side 58 and an opposite bottom side 59. The top side faces the cable and is preferably flush with the pylon's upper surface. The latch body includes a chamber 60 having an opening 62 in the top side through which the top 48 of the locking pin 44 protrudes. The chamber wall forms a circumferential ledge 64 recessed into the latch body. The locking pin includes a region 66 having a thinner diameter to accommodate a stack of Belleville washers 68.

The stack of washers is retained at the bottom by a dome-shaped plug 70 having a circumferential flange 72 to support the stack. When the locking pin 44 is engaged with a connector 36, the pin is pulled outward slightly in its locking position. The Belleville washers are compressed between the flange 72 and the ledge 64 of the chamber 60. In this way they apply a biasing spring force acting to retract the pin back into the chamber and, consequently, holding the connector tightly to the top of the pylon 26.

[0014] The latch body 56 preferably includes a bore 74 through which a retainer 76, such as a set screw, can extend. The housing pylon 26 includes aligned threaded bores 77, 78, which the set-screw retainer engages. The retainer retains the latch body 56 to the housing. The retainer can also serve to prevent the top of the locking pin 44 from dropping below the top side 58 of the latch body when the device is not engaged with a connector 36 and the Belleville washer stack 68 is relaxed, allowing the pin to bottom out against the retainer.

[0015] An access hole 79 formed in the front pylon 26 (and a similar access hole 79' in the rear pylon 26) extends into the latch cavity 54. An access aperture 80 formed in the latch body 56 is aligned with the access hole to admit a tool 82 into the locking pin chamber 60. The inserted tool can be used to lift the locking pin 44 up against spring pressure to an unlocked position for removing the bird from and installing it on a connector 36. In removing birds, once the locking pin is clear of the receptacle, the tool can be removed from the access hole. In attaching birds, the tool can be removed once the locking pin is in its locked position at the end of the receptacle slot. A screwdriver or other such shafted tool can also be used.

[0016] One version of tool that works well is shown in FIG. 4. The tool 82 has a first shaft portion 84 and a second shaft portion 85 forming an eccentric camming surface on the second shaft portion. An end portion 86 of the tool is similar to the first portion, but includes a flat surface 87. The tool is inserted into the chamber 60 through the aligned access hole 79 and access aperture 80. The flat surface 87 makes it easier for the tool to slip under the dome-shaped plug 70 at the bottom of the locking pin 44. The tool is inserted until the eccentric portion 85 is under the dome-shaped plug. The end portion 86 is supported by the walls of the access hole and aperture on the other side of the latch body. As the tool is rotated, the eccentric camming surface, which is eccentric relative to the first shaft portion and the end portion, engages the dome-shaped plug and raises and lowers the locking pin between unlocked and locked positions. The tool includes a handle 88 for better leverage. This allows for easy deployment of devices on a streamer cable and eliminates the need for a costly eccentric cam to be built into each latch mechanism.

[0017] During collisions between birds and underwater debris or vessel structures, the impact typically imparts a force with a component in the direction of arrow 90 (FIG. 5) that tends to separate the bird from the cable. In many instances, the force can be so great that the housings of conventional birds or other cable-attached devices can be irreparably damaged This is especially true of devices that include a heading sensor, for which even relatively small distortions in the housings can cause intolerable alignment errors. As shown in the latch body version of FIG. 5, when the component of force 90 acting on the latch body increases above a predetermined level, a thin portion 92 of the latch body around the bore 74 gives way under pressure from the retainer 76. Acting as a sacrificial element, the broken-away portion prevents the force of impact from reaching a level great enough to damage the rest of the housing 22. The force required to break the sacrificial element can be taken into account in designing the part. For example, the thickness of the material around the bore 74 can be changed to withstand different levels of forces. As shown in FIG. 3, the bottom side 59 of the latch body can include a void 94 to lessen the amount of material around the bore subject to the pressure of the retainer. A variety of materials can be used to construct the latch body 56 to tailor its failure loads and modes for different applications. Particularly suitable materials for the latch body include moldable plastics because of their versatility, light weight, and corrosion-resistance, but other materials could also be used. It is also possible to use other parts of the overall latch mechanism 52 as the sacrificial element. For example, as shown in FIGS. 6A and 6B, another version of a retainer 96 has a frangible region 97 that breaks under pressure from the walls of the surrounding bore 74 of the latch body 56. The frangible region could be formed by a thinner diameter material, as shown, or by making the retainer out of a different material than a typical steel set screw, such as a plastic or ceramic or other more brittle or generally weaker material.

[0018] Once the sacrificial element gives way upon impact, the bird 20 is still retained to the cable 21 by the latch mechanism 52 at the other pylon or, in the event both latch mechanisms are sacrificed, by a lanyard (not shown) attached to the housing 22 and looped around the cable. The bird merely has to be retrieved and the broken sacrificial latch mechanism replaced by a good one before returning to service. There is no need to replace the entire bird with another and send the damaged bird back to the factory for repair or disposal.

[0019] Although the invention has been described in detail with reference to preferred versions, other versions are possible. For example, the inner ring/outer connector assembly was used throughout as an exemplary mounting element for attaching devices to underwater cables. Other mounting elements that are engageable by a locking member extending between the mounting element and a latch body could equivalently be used. The locking pin need not be a dovetail pin as described. Other locking and latching schemes could be substituted for the dovetail/slot scheme described in the

depicted versions. Hooks, clasps, and bolts are only a few of the locking elements that one could substitute for the dovetail pin described. The sacrificial element could be realized in other ways. The retainer need not extend all the way through the latch body and need not be a set screw. A shear pin or other frangible structure could be used to retain the latch body in normal operation and to yield under preselected levels of force acting on the latch body. It is clear that one skilled in the art would recognize many equivalent structures for attaching devices to underwater cables. Although the description used the cable-leveling bird as a exemplary cable-attached device, other devices, such as acoustic ranging devices, cable retrieval devices, flotation devices, and other sensing devices, could derive benefit from the features embodied in the described versions. The invention also has application on untowed bottom cables to which similar devices are attached.

Claims

1. A connector connectable to an underwater cable for connecting a device (20) to a mounting element (36) on the underwater cable, said connector comprising:

   a latch body (56) having a locking member (44) for securing the latch body (56) to the mounting element (36);
   a retainer (76) for forming an engagement between the latch body and a housing (26) of the device (20);

   characterised in that the engagement between the latch body (56) and the device housing (26) is sacrificially frangible to release the engagement of the latch body (56) with the housing (26) in response to force in excess of normal operating forces acting on the latch body.

2. A connector as claimed in claim 1 wherein a portion (92) of the latch body (56) is sacrificially frangible to release the engagement.

3. A connector according to claim 2 wherein the latch body has a bore (74) and the retainer (76) extends through the bore (74) and wherein a portion (92) of the latch body around the bore (74) is sacrificially frangible.

4. A connector according to claim 1 wherein the retainer is sacrifically frangible.

5. A connector according to any one of the preceding claims wherein the latch body (56) is insertable into a cavity (54) in the housing (26) of the device (20).

6. A connector according to claim 5 wherein, in use, the retainer (76) extends through a bore (74) in the latch body (56) into the wall of the housing (26).

Patentansprüche

1. Verbinder, der mit einem Unterwasserkabel verbunden werden kann, um eine Vorrichtung (20) an ein Montageelement (36) auf dem Unterwasserkabel anzuschließen, wobei der Verbinder umfasst:

   einen Einrast-Körper (56), der ein Arretierelement (44) aufweist, um den Einrast-Körper (56) am Montageelement (36) zu sichern;

   eine Rückhalteeinrichtung (76), um einen Eingriff zwischen dem Einrast-Körper und einem Gehäuse (26) der Vorrichtung (20) zu bilden;

   dadurch gekennzeichnet, dass der Eingriff zwischen dem Einrast-Körper (56) und dem Vorrichtungsgehäuse (26) irreversibel zerbrechbar ist, um den Eingriff des Einrast-Körpers (56) mit dem Gehäuse (26) als Reaktion auf eine Kraft, die die normalen auf den Einrast-Körper wirkenden Betriebskräfte übersteigt, zu lösen.

2. Verbinder nach Anspruch 1, worin ein Abschnitt (92) des Einrast-Körpers (56) irreversibel zerbrechbar ist, um den Eingriff zu lösen.

3. Verbinder nach Anspruch 2, worin der Einrast-Körper eine Bohrung (74) aufweist und sich die Rückhalteeinrichtung (76) durch die Bohrung (74) erstreckt und worin ein Abschnitt (92) des Einrast-Körpers um die Bohrung (74) irreversibel zerbrechbar ist.

4. Verbinder nach Anspruch 1, worin die Rückhalteeinrichtung irreversibel zerbrechbar ist.

5. Verbinder nach einem der vorangegangenen Ansprüche, worin der Einrast-Körper (56) in einen Hohlraum (54) im Gehäuse (26) der Vorrichtung (20) einsetzbar ist.

6. Verbinder nach Anspruch 5, worin sich bei Verwendung die Rückhalteeinrichtung (76) durch eine Bohrung (74) im Einrast-Körper (56) hindurch in die Wand des Gehäuses (26) erstreckt.

Revendications

1. Connecteur pouvant être connecté à un câble sous-marin pour connecter un dispositif (20) à un élément de montage (36) sur le câble sous-marin, ledit con-

necteur comprenant :

un corps de verrouillage (56) possédant un élément de blocage (44) pour fixer le corps de verrouillage (56) à l'élément de montage (36) ;

un élément de retenue (76) pour réaliser un engagement entre le corps de verrouillage et un boîtier (26) du dispositif (20) ;

caractérisé en ce que l'engagement entre le corps de verrouillage (56) et le boîtier (26) du dispositif peut être sacrifié en le cassant pour relâcher l'engagement du corps de verrouillage (56) dans le boîtier (26) en réponse à une force dépassant les forces de fonctionnement normales agissant sur le corps de verrouillage.

2. Connecteur selon la revendication 1, où une portion (92) du corps de verrouillage (56) peut être sacrifiée en le cassant pour relâcher l'engagement.

3. Connecteur selon la revendication 2, où le corps de verrouillage présente un perçage (74), et l'élément de retenue (76) s'étend à travers le perçage (74), et où une portion (92) du corps de verrouillage autour du perçage (74) peut être sacrifiée en le cassant.

4. Connecteur selon la revendication 1, où l'élément de retenue peut être sacrifié en le cassant.

5. Connecteur selon l'une des revendications précédentes, où le corps de verrouillage (56) peut être inséré dans une cavité (54) dans le boîtier (26) du dispositif (20).

6. Connecteur selon la revendication 5, où en cours d'utilisation, l'élément de retenue (76) s'étend à travers un perçage (74) dans le corps de verrouillage (56) dans la paroi du boîtier (26).

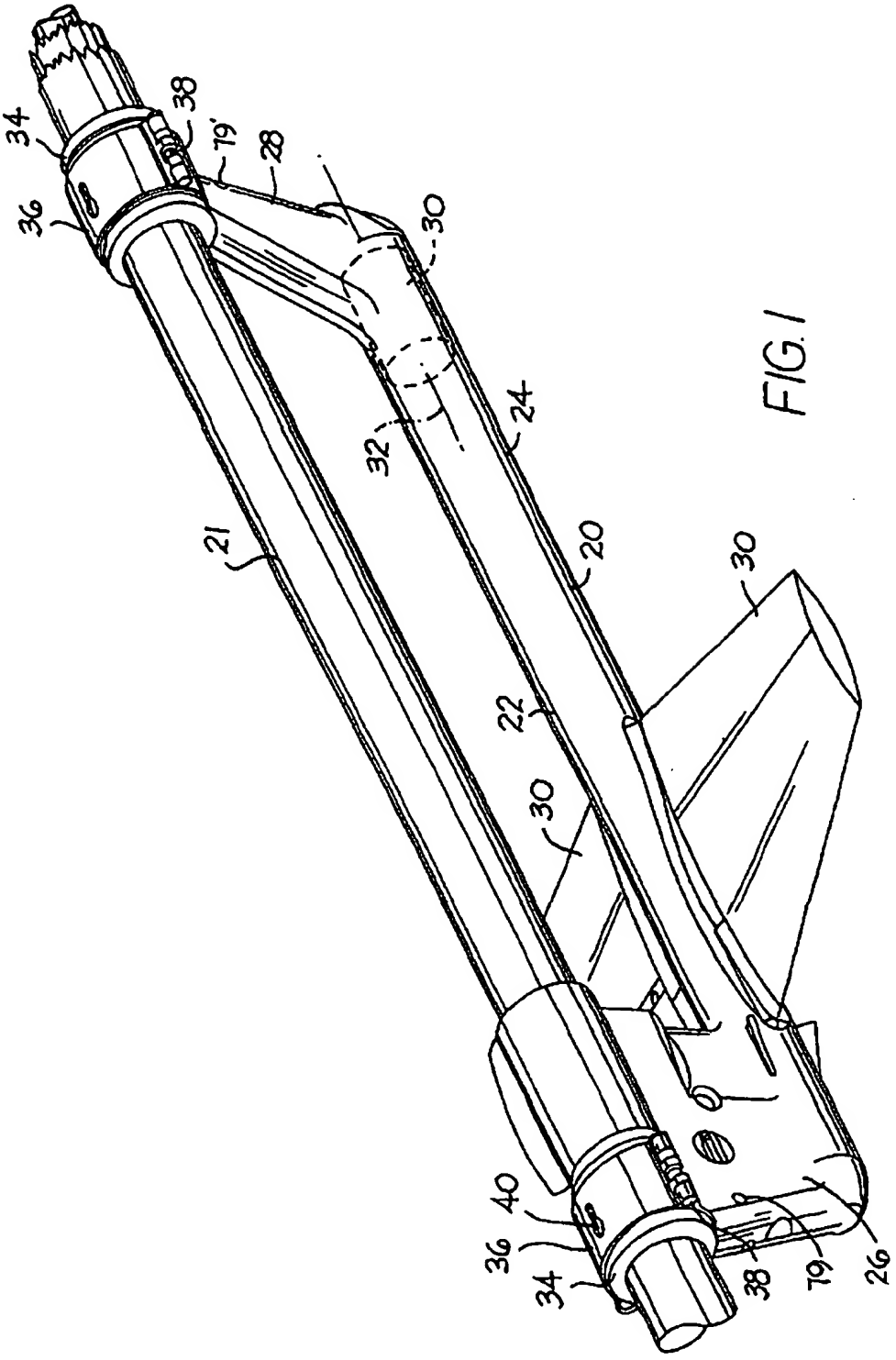


FIG. 1

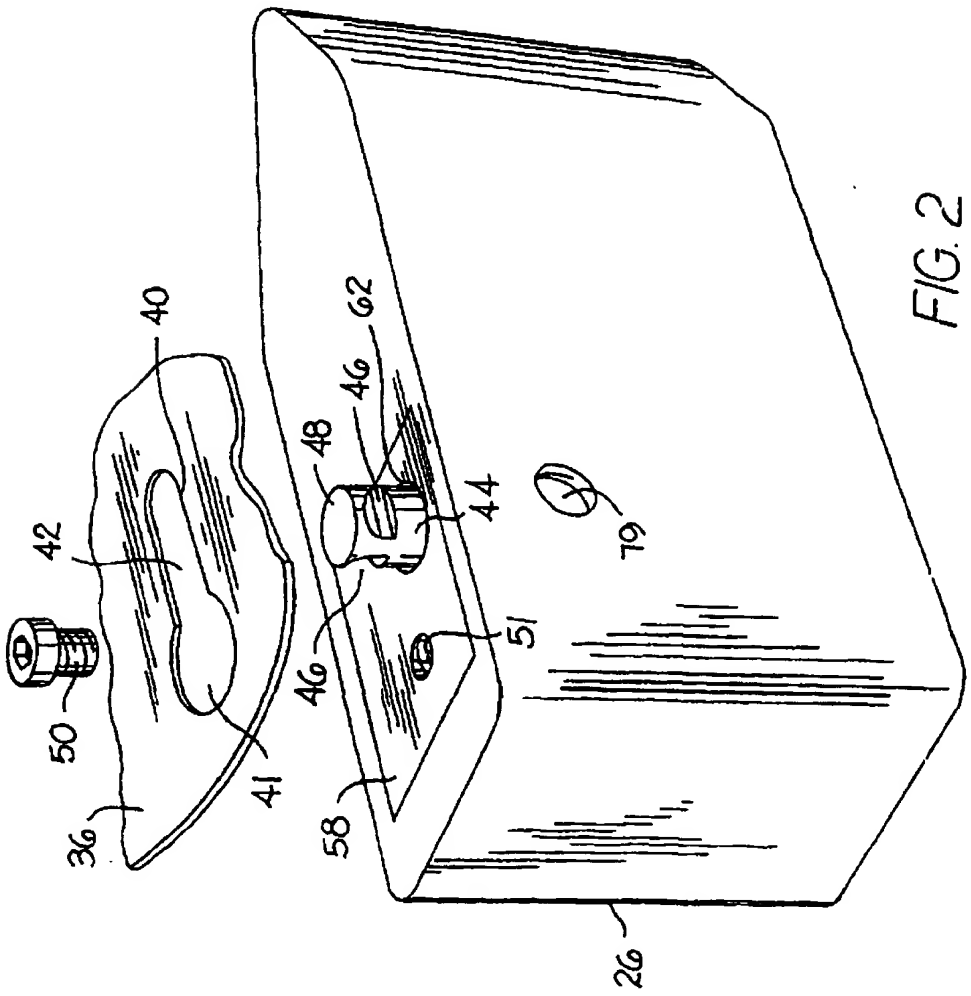


FIG. 2

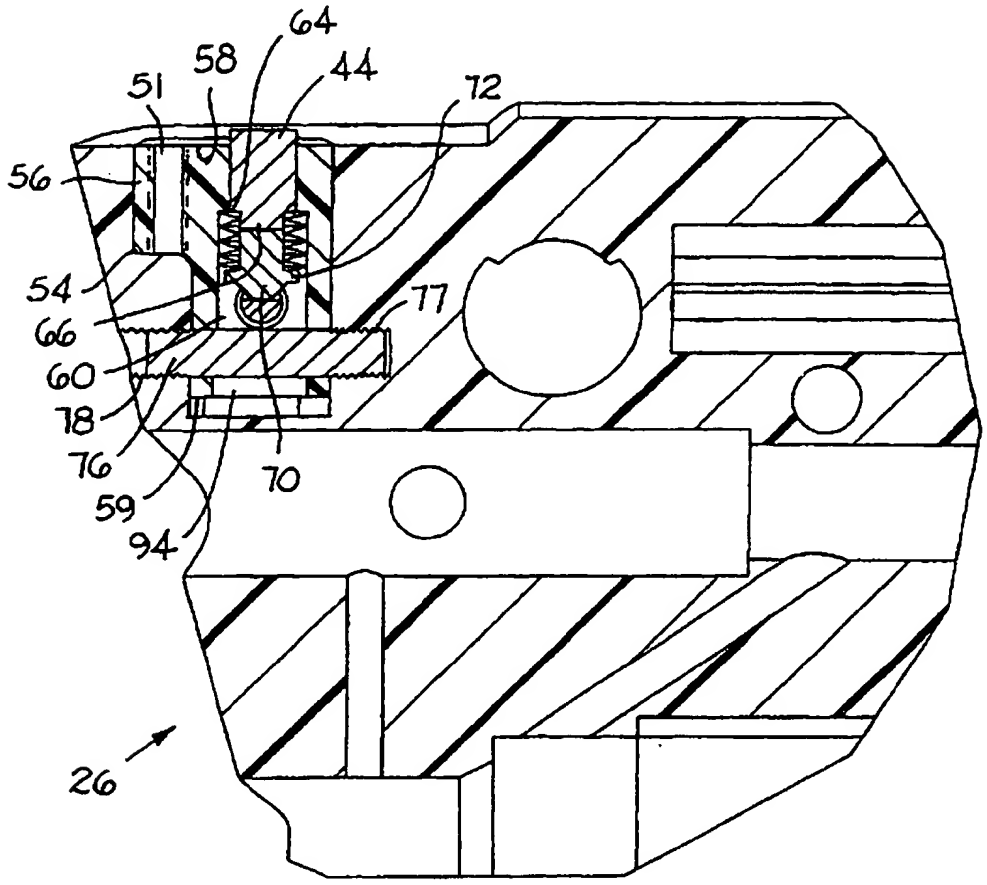
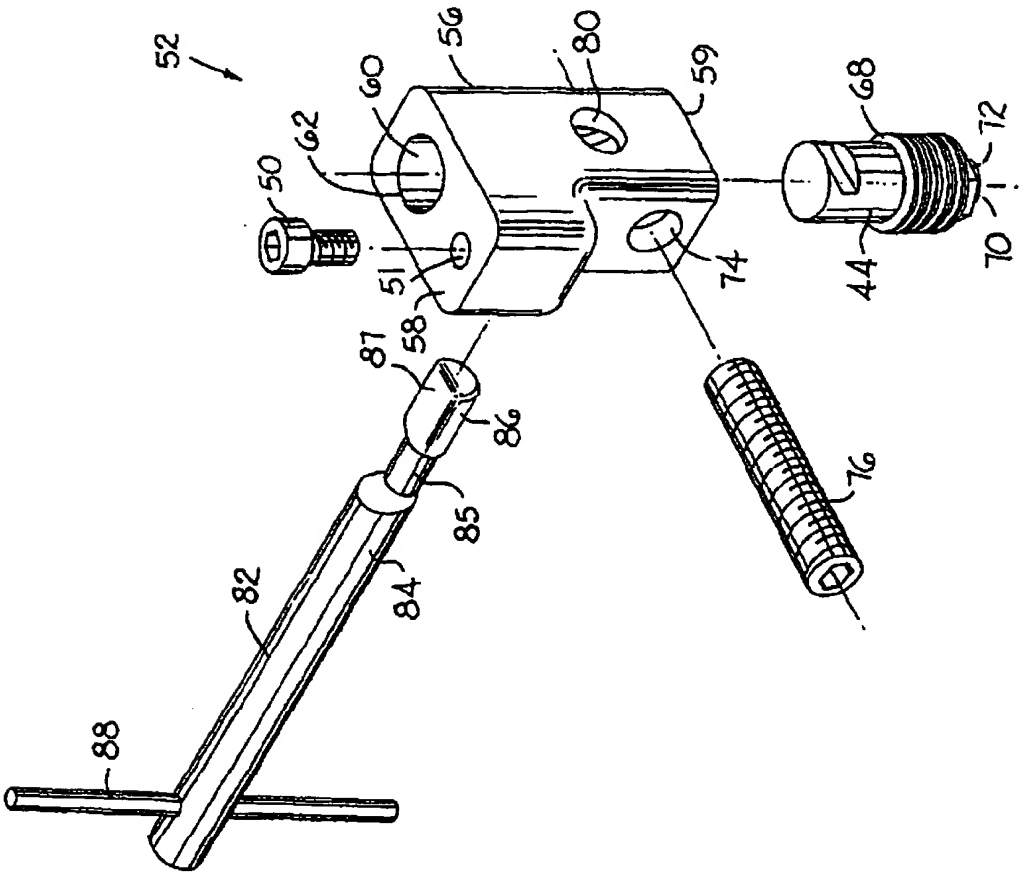


FIG. 3

FIG. 4



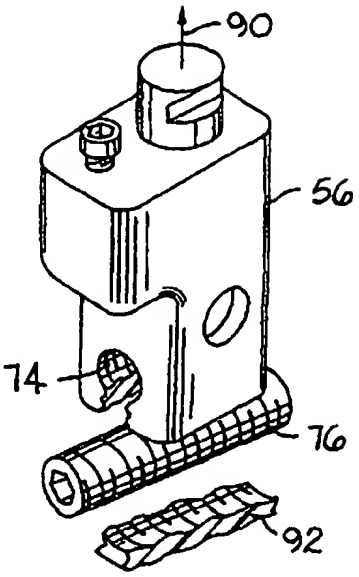


FIG. 5

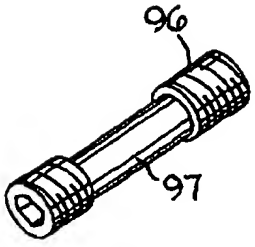


FIG.6A

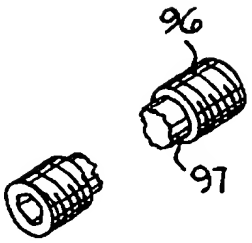


FIG.6B